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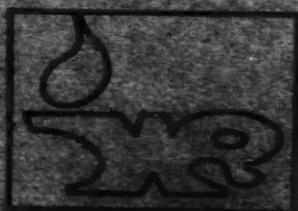
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ABSTRACT

Data are reported for the classroom observational portion of a cross-sectional study conducted in Tasmania, Australia to examine the acquisition and development of addition and subtraction skills in young children. During the study, a group of students in grades 1, 2, and 3 who differed in cognitive processing skills were observed during mathematics instruction. Frequencies of teacher and pupil behaviors observed in each of five classrooms during a period of three months in 1980 are reported, as well as a brief discussion of results. From these data, it can be concluded that variations in allocated time are due not to differences in cognitive level of children but to difference in the actions of teachers, school policy and procedures, or grade level of instruction. (MNS)

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Working Paper No. 326

Classroom Learning: Results from Observations - Sandy Bay Study

by THOMAS A. Romberg, Kevin E. Collis,
Anne E. Buchanan, and Martha N. Romberg

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July 1980

Wisconsin Center for Education Research

an institute for the study of diversity in education

Working Paper No. 326

CLASSROOM LEARNING: RESULTS FROM OBSERVATIONS--SANDY BAY STUDY

by

Thomas A. Romberg, Kevin F. Collis,
Anne E. Buchanan, and Martha N. Romberg

Report from the Project on
Studies in Mathematics

The Research Committee of
The University of Wisconsin Graduate School

Wisconsin Center for Education Research
The University of Wisconsin-Madison
Madison, Wisconsin, USA

and

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Hobart, Tasmania, Australia

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Abstract

This paper reports data gathered for the classroom observational portion of a cross-sectional study examining the acquisition and development of addition and subtraction skills in young children. During the study, a group of students who differed in cognitive processing skills were observed during mathematics instruction. Frequencies of teacher and pupil behaviors observed in each of five classrooms during a period of three months are reported as well as a brief discussion of results. From this data, it can be concluded that variations in allocated time are due not to differences in cognitive level of children but to differences in the actions of teachers, school policy and procedures, or grade level of instruction.

This paper reports the results from one of a series of related, collaborative studies carried out in Tasmania, Australia, in 1979 and 1980. In those studies, we examined how young children acquire the skills to represent and solve a variety of verbal addition and subtraction problems. We assumed that the evolution of children's performance on addition and subtraction tasks must be related both to their cognitive abilities and to their engagement in related instructional activities. The purpose of the study reported in this paper was to relate the cognitive capacity and grade level of children to observed pupil actions and teacher actions during instruction. In particular, the following question was addressed: Do children who differ in cognitive capacity receive different instruction?

The Collaborative Studies

This series of studies was jointly funded by the Research Committee of the Graduate School at the University of Wisconsin, the University of Wisconsin Center for Education Research, and the University of Tasmania. The principal investigators of the studies brought different backgrounds and skills to this collaborative effort. The identification of cognitive abilities grows out of Professor Collis' extensive work in cognitive development (for example, see Biggs & Collis, 1982). The classroom engagement ideas stem from Professor Romberg's research on teaching (see Romberg, Small, & Carnahan, 1979).

The strategy adopted for the sequence of collaborative studies has five steps:

1. Identify M-space for a population of children of ages 4-8.
2. Identify "cognitive processing capabilities" for the same set of children.
3. From (1) and (2) identify a well defined set of children with specific cognitive characteristics.
4. From (3) identify a sample of children and observe their engagement in instructional activities on related tasks for three months.
5. Repeatedly measure, on three occasions over the three-month period, the sample's performance and note the strategies they use with addition and subtraction problems.

This procedure allowed us to relate level of performance achieved and strategy adopted at a given time to the child's cognitive capability and to the specific set of instructional activities the child was engaged in. In this way we can consider various questions about change in performance and strategy and their possible causes.

This Study

The importance of knowing how children learn the concepts and procedures of addition and subtraction should be self-evident. Also, it is frequently assumed that children must first master such computational skills before they can begin to solve addition and subtraction problems. However, it has been clearly demonstrated that children develop a variety of strategies for solving mathematical problems independent of instruction (cf. Carpenter & Moser, 1979; Ginsburg, 1977; Resnick, 1978). In fact, many of the strategies are more sophisticated and demonstrate more insight than the procedures that are taught. These findings raise questions about

the relationships of children's instructional experience and their capacity to their performance and their selection of strategies.

The sample of children from the population used in the previous studies in this series (Romberg & Collis, 1980a, 1980b; Romberg, Collis, & Buchanan, 1981, 1982) were observed during instruction over a three-month period in 1980 (February 27-May 28). Teachers kept logs of time spent on content areas, and trained observers coded both pupil actions and teacher actions during instruction on a sample of days. This report presents the data about instruction from logs and observations.

Cognitive Capacity

To identify children with differing cognitive capacities, a three step procedure was followed. First, we identified memory capacity (M-space) for a population of children of ages 4-8 (Romberg & Collis, 1980a). Four M-space tests were administered.

Second, we identified cognitive processing capabilities for the same set of children (Romberg & Collis, 1980b). Fifteen different tests were given. From a factor analysis of those scores, a quantitative factor, a qualitative correspondence factor, and a logical reasoning factor were identified.

Third, from those data we identified six groups of children with specific cognitive characteristics. A cluster analysis procedure was used to group the children.

Cognitive Level 1 children operate at M-space level 1, are capable of handling qualitative comparisons and transformations at a moderate

level, and are incapable of dealing with quantitative tasks or logical reasoning. Cognitive Level 2 children operate at M-space level 2, handle qualitative correspondence tasks, and cannot handle quantitative and logical skills (but were considerably better than Cognitive Level 1 on all tasks). Cognitive Level 3 children also operate at M-space level 2, are high on qualitative correspondence, have developed the specific counting skills of counting-on and counting-back, are inadequate in their use of those counting skills on the transitive reasoning, and are inadequate on logical reasoning. Cognitive Level 4 children operate at M-space level 3, are high on qualitative correspondence and all the quantitative tests, but are inadequate on the logical reasoning test. Cognitive Levels 5 and 6 are at M-space levels 3 and 4. They reach the ceiling on the qualitative correspondence tests, have very high scores on all quantitative tests, and also are high on logical reasoning.

Because these latter two groups were both small, included only third graders, and displayed no differences in cognitive processing scores, the observation data for these children have been combined. The number of children selected to be observed in each group of children in each class in each grade is shown in Table 1. Our intent was to have a sample of one student from each cognitive level in each class. However, not all classes had children in each group. We began with rosters of students from each grade and their cognitive level.

Classroom observation. During the three-month period, a trained observer was present in each class while arithmetic was being taught. Records of what material was being taught were provided by each teacher.

Table 1

Children in Each Cognitive Level in Each Class Used in the Observation Study

Cognitive Level	Sandy Bay Infant School		Class	Waimea Heights Primary School		
	1	2		3	4	5
	Grade 1	Grade 2		Grade 3	Grade 3	Grade 3
1	2	2				
2	3	4			3	
3	1	2		2	2	2
4				2	2	2
5,6				3	1	2
Totals	6	8		7	8	6

The observer coded pupil-teacher interactions, pupil-pupil interactions, individual work; most importantly, amount of engaged time of selected pupils was obtained.

The observational data were gathered from a content perspective. Our attempt was to determine the way in which aspects of content influence certain teacher behaviors during instruction and in turn how these actions affect pupil outcomes. In particular, the extent to which children are engaged in learning mathematics is being examined. A model of classroom instruction was constructed where "content segmentation and sequencing" and "content structuring" were hypothesized to influence teacher planning which in turn influences classroom organization, the allocation of instructional time, verbal interactions within classroom, and, eventually pupil engaged time. (See Romberg, Small, & Carnahan, 1979, for a complete explication of the model.) To test this model, data have been gathered on various components of the model in realistic classroom settings for several periods of time. (See Romberg, Small, Carnahan, & Cookson, 1979, for a description of coding procedures used as well as detailed explanations of coding categories.) From such data the relationship of the model to the reality of classroom instruction as it is observed in the field can be examined.

Summary of Procedure and Aggregation of Data

Data were collected on content covered and on certain teacher and pupil behaviors involved in the teaching and learning of mathematics using two procedures. First, to estimate time spent on various mathematics objectives, teachers were asked to log the number of minutes of

instruction each target child received in nine content areas. In Table 2 the percentage of total time spent on each content area is presented. Overall, these data reflect the curricular emphasis common in these grades. Almost half of the time is spent on mathematics other than addition and subtraction (much on multiplication and division). The only disturbing percentages indicate the little time spent on verbal problems (either writing sentences or finding solutions).

Second, the pupil action and teacher action data were gathered by three trained observers using an observation coding form. One observer worked at Sandy Bay Infant School and observed both the Grade 1 and Grade 2 classes. The other two worked at Waimea Heights Primary School where one observed two classes. Each was able to observe instruction in a class approximately 24 days during the observation period. At the schools, the observers sat in a class and over time became a fixture who did not distract either teacher or children. The exact nature of the data collected and the method used to gather it are described fully in the manual produced by the project staff to train observers (Romberg, Small, Carnahan, & Cookson, 1979).

In brief, student and teacher verbal behaviors were observed in each class on a sample of days. A time-sampling procedure was used in which each of the six to eight "target" students was observed in a particular sequence at different moments throughout the observation period. The sequence in which the students were observed was fixed prior to the beginning of the observation period and was invariant while observations were taking place. The teacher was coded for instances of relevant verbal behavior each time a target student was

Table 2

Percentage of Time Spent on Mathematical Content Areas
by Grade--Teacher Log Data

∞

Content Area	<u>Grade 1</u>	<u>Grade 2</u>	<u>Grade 3</u>
	(24 days, 50-60 min/day)	(24 days, 50-55 min/day)	(111 days, 30 min/day)
Numerousness	14.3	6.4	4.5
Ordering	5.2	5.6	2.1
Basic Facts	15.5	13.3	4.0
(add)	(14.7)	(6.8)	(3.1)
(subtract)	(.8)	(6.5)	(.9)
Problem Solving	2.6	1.4	4.2
Sentence Writing	.8	.8	3.1
Algorithms	0	3.1	24.0
(add)	(0)	(3.1)	(13.4)
(subtract)	(0)	(0)	(10.6)
Counting	9.3	12.4	1.4
Other Arithmetic	13.2	16.8	15.6
Other Maths	39.1	33.0	41.1

observed. The observation of all six to eight students, along with the teacher six to eight times, represented a coding cycle. It was estimated that one minute was needed to (a) observe the target student's behavior, (b) observe the teacher, (c) observe organizational aspects of the classroom, and (d) code the appropriate categories on the observation form. The behavior to be coded consisted only of those activities the teacher and pupil were involved in precisely at the beginning of the one-minute time interval. It was expected that through this process, observer bias in sampling moments would be minimized. The coding categories were used to record a description of what was occurring at that one instant for both the target student and the teacher. In this way a series of "snap shots" would be obtained which would give a running account of what took place in the classroom for a particular observation period.

Observation for a class session began when mathematics instruction began and ended when mathematics instruction for that class session ended. The basic data are in the form of frequency counts for each behavior category coded. For purposes of interpretation, the proportional occurrence of each behavior (based on total observed instances) is used. Data have been aggregated separately for each class in two formats--by day, each period of instruction, and for the total period. Data aggregated by day are not reported here. The data on the total period are reported to give an overall picture of the teaching of mathematics in each class and yield estimates of how instructional factors affect engagement rates.

Data Aggregation and Analysis

The observational data gathered in this study have been summarized in three categories: pupil actions, teacher behaviors, and teacher behavior-pupil engagement interactions. Pupil actions have been summarized as engaged or off-task; if engaged, whether it was on content or directions. Grouping and interactions were summarized for the total observation period; the other party to interactions was identified. Teacher behaviors have been summarized in terms of their interactions with the class and not just the target children, speaking to group, speaking on content or directions, questions, feedback and type of explanations. Interactions of teacher behaviors and pupil engagement have been summarized in terms whether pupils are engaged when the teacher is speaking, speaking to groups, listening, no teacher interactions, questioning, and provides information.

The plan for the analysis of the observational data was based on the fact that there were two primary dimensions in the study: cognitive level of the pupils and grade. The raw data are observed minutes. The number of minutes and percentage of time are aggregated in this analysis in four ways: (1) for all pupils with respect to cognitive level; (2) by grade; (3) by class in grade 3; and (4) by cognitive level within class.

Ideally, statistical analyses to test main effects and interactions for such a data matrix involves developing log-linear models for an incomplete frequency table, using the Newton-Raphson algorithm for computation of maximum-likelihood estimates in terms of a series of weighted

regression analyses, and then testing the estimates (using chi-square statistics) to explore the adequacy of each model (Haberman, 1978). Unfortunately, for this study such a complex analysis was not possible. The small number of subjects, the unequal cell sizes, the extensive incompleteness of the matrix, and lack of resources have limited us to describing the frequencies and testing a few of the differences with chi-square statistics.¹

Pupil Actions

The data for number of minutes and percentage of time for children are first presented in terms of cognitive level. Then the same information is presented by grade, by class in Grade 3, and by cognitive level/class interactions.

Cognitive level. The number of minutes and percent of time coded to the five pupil action categories are presented in Table 3. Overall, the percent of engaged time steadily increases across cognitive levels. In fact, the differences in percentage engaged from CL1 to CL5,6 (64% to 87%) is significant ($\chi^2 = 71.10$, $p < .01$). Also, differences in grouping are striking with percentage of time in large group instruction varying from 21% for CL1 to 68% for CL5,6 children. This difference is

¹Because of the large number of cells, and the lack of a systematic plan to test differences, an alpha level of .01 was arbitrarily chosen to test significance. In addition, tests which yielded probability values between an alpha of .05 and .01 ($.05 > p > .01$) were considered marginally significant. All χ^2 values were calculated via 2 x 2 contingency tables where frequency of time spent was dichotomized.

Table 3
Observed Minutes and Percent of Time of Pupil Actions
by Cognitive Level of Children

	Cognitive Level 1 min/%	Cognitive Level 2 min/%	Cognitive Level 3 min/%	Cognitive Level 4 min/%	Cognitive Level 5,6 min/%
Engagement					
Engaged Time	420/64	850/65	721/70	331/76	377/87
Off-task Time	237/36	460/35	310/30	106/24	56/13
Types of Engagement ¹					
Content	361/86	690/83	634/90	282/88	326/91
Directions	57/14	140/17	68/10	37/12	31/9
Grouping					
Individual	167/25	201/15	104/10	0/0	6/1
Small Group	356/54	593/45	444/43	129/29	138/31
Large Group	135/21	510/39	496/48	317/71	300/68
Interactions					
Target Speaking	37/6	61/5	63/6	19/4	38/9
Target Listening	76/12	164/12	162/15	62/14	69/16
None	545/83	1090/83	825/79	367/82	338/76
Interaction Other Party					
Teacher	80/71	167/74	162/73	67/83	80/78
Pupil	24/21	46/20	55/25	14/17	22/21
Other Adult	9/8	12/5	6/3	0/0	1/1

¹Many of the minutes observed in subcategories fail to sum to the total time because of other codes which were infrequently used or data were missing or coding errors.

also significant ($\chi^2 = 245.65$, $p < .01$). All other differences in percentage of time coded to the pupil action categories are not striking or of practical interest.

Grade. The data on pupil actions by grade are presented in Table 4. The striking engagement rate and grouping differences found for the cognitive level aggregation are found here, leading us to believe the differences are more due to grade than to cognitive level.

Class in Grade 3. For Grade 3 the data have been further subdivided into pupil actions by class, as shown in Table 5. Class 2 is clearly different from the other two classes. Pupils in that class were off-task more of the time. If they were engaged, pupils were more likely to be engaged on directions; and if they were interacting, pupils were more likely to be interacting with other pupils.

This suggests that differences in grouping is a function of grade, while differences in engagement and interactions are a function of teacher.

Cognitive level within class. The data for children of different cognitive levels within Grade 1 are presented in Table 6. Only one difference, pupil/pupil interactions, is even marginally significant between CL1 and CL3 children (24% to 45%, $\chi^2 = 4.60$, $.01 < p < .05$).

The data for Grade 2 children at different cognitive levels are presented in Table 7. As for Grade 1, the only observable difference is in pupil/pupil interactions (17% to 32%) but in this case the difference is not significant ($\chi^2 = 3.25$, $p < .05$).

Tables 8, 9, and 10 contain the within-class data for children at different cognitive levels for the three third-grade classes.

Table 4

Observed Minutes and Percent of Time of Pupil Actions by Grade

	Grade 1 min/%	Grade 2 min/%	Grade 3 min/%
Engagement			
Engaged Time	559/55	771/71	1369/77
Off-task Time	449/45	317/29	403/23
Types of Engagement ¹			
Content	488/89	656/86	1149/88
Directions	62/11	107/14	164/12
Grouping			
Individual	302/30	165/15	11/1
Small Group	553/55	583/53	524/29
Large Group	156/15	343/31	1259/70
Interactions			
Target Speaking	62/6	51/5	105/6
Target Listening	91/9	163/15	279/15
None	858/85	880/80	1427/79
Interaction Other Party			
Teacher	99/65	161/76	296/78
Pupil	48/31	36/17	77/20
Other Adult	6/4	16/8	6/2

¹ Many of the minutes observed in subcategories fail to sum to the total time because of other codes which were infrequently used or data were missing or coding errors.

Table 5
Observed Minutes and Percent of Time
of Pupil Actions by Class in Grade 3

	Class 1 min/%	Class 2 min/%	Class 3 min/%
Engagement			
Engaged Time	402/98	650/64	317/90
Off-task Time	8/2	358/36	37/10
Types of Engagement ¹			
Content	364/95	496/79	289/97
Directions	21/5	135/21	8/3
Grouping			
Individual	6/1	0/0	5/1
Small Group	101/24	247/25	176/47
Large Group	317/75	750/75	192/51
Interactions			
Target Speaking	24/6	52/5	29/8
Target Listening	112/26	127/13	40/11
None	289/68	835/82	303/81
Interaction Other Party			
Teacher	122/92	119/67	55/81
Pupil	10/8	57/32	10/15
Other Adult	1/1	2/1	3/4

¹ Many of the minutes observed in subcategories fail to sum to the total time because of other codes which were infrequently used or data were missing or coding errors.

Table 6
Observed Minutes and Percent of Time of Pupil Actions
by Cognitive Level Within Grade 1

	Cognitive Level 1 min/%	Cognitive Level 2 min/%	Cognitive Level 3 min/%
Engagement			
Engaged Time	260/60	189/51	110/54
Off-task Time	174/40	181/49	94/46
Types of Engagement ¹			
Content	230/89	159/87	99/90
Directions	28/11	23/13	11/10
Grouping			
Individual	129/30	119/32	54/26
Small Group	235/54	197/53	121/59
Large Group	70/16	56/15	30/15
Interactions			
Target Speaking	25/6	24/6	13/6
Target Listening	41/9	30/8	20/10
None	368/85	318/85	172/84
Interaction Other Party			
Teacher	46/70	36/67	17/52
Pupil	16/24	17/31	15/45
Other Adult	4/6	1/2	1/3

¹ Many of the minutes observed in subcategories fail to sum to the total time because of other codes which were infrequently used or data were missing or coding errors.

Table 7
Observed Minutes and Percent of Time of Pupil Actions
by Cognitive Level Within Grade 2

	Cognitive Level 1 min/%	Cognitive Level 2 min/%	Cognitive Level 3 min/%
Engagement			
Engaged Time	160/72	399/72	212/69
Off-task Time	63/28	158/28	96/31
Types of Engagement ¹			
Content	131/82	336/85	189/90
Directions	29/18	57/15	21/10
Grouping			
Individual	38/17	82/15	45/14
Small Group	121/54	294/53	168/54
Large Group	65/29	179/32	99/32
Interactions			
Target Speaking	12/5	20/4	19/6
Target Listening	35/16	84/15	44/14
None	177/79	454/81	249/80
Interaction Other Party			
Teacher	34/72	87/84	40/65
Pupil	8/17	8/8	20/32
Other Adult	5/11	9/9	2/3

¹ Many of the minutes observed in subcategories fail to sum to the total time because of other codes which were infrequently used or data were missing or coding errors.

Table 8
Observed Minutes and Percent of Time of Pupil Actions
by Cognitive Level Within Class 1, Grade 3

	Cognitive Level 3 min/%	Cognitive Level 4 min/%	Cognitive Level 5,6 min/%
Engagement			
Engaged Time	144/98	80/96	178/99
Off-task Time	3/2	3/4	2/1
Types of Engagement ¹			
Content	127/93	76/96	161/95
Directions	10/7	3/4	8/5
Grouping			
Individual	5/3	0/0	1/0
Small Group	33/22	20/23	48/26
Large Group	114/75	67/77	136/74
Interactions			
Target Speaking	8/5	2/2	14/8
Target Listening	47/31	16/18	49/29
None	98/67	69/79	122/66
Interaction Other Party			
Teacher	52/95	16/94	54/89
Pupil	3/5	1/6	6/10
Other Adult	0/0	0/0	1/1

¹ Many of the minutes observed in subcategories fail to sum to the total time because of other codes which were infrequently used or data were missing or coding errors.

Table 9
Observed Minutes and Percent of Time of Pupil Actions
by Cognitive Level Within Class 2, Grade 3

	Cognitive Level 2 min/%	Cognitive Level 3 min/%	Cognitive Level 4 min/%	Cognitive Level 5,6 min/%
Engagement				
Engaged Time	262/68	151/69	148/62	89/67
Off-task Time	121/32	101/40	92/38	44/33
Types of Engagement ¹				
Content	195/76	119/83	112/77	70/80
Directions	60/24	24/17	33/23	18/20
Grouping				
Individual	0/0	0/0	0/0	0/0
Small Group	102/27	62/25	51/21	32/24
Large Group	275/73	187/75	187/79	101/76
Interactions				
Target Speaking	17/4	14/6	8/3	13/10
Target Listening	50/13	36/14	30/12	11/8
None	318/83	204/80	203/84	110/82
Interaction Other Party				
Teacher	44/66	33/67	29/76	13/54
Pupil	21/31	16/33	9/24	11/46
Other Adult	2/3	0/0	0/0	0/0

¹ Many of the minutes observed in subcategories fail to sum to the total time because of other codes which were infrequently used or data were missing or coding errors.

Table 10
Observed Minutes and Percent of Time of Pupil Actions
by Cognitive Level Within Class 3, Grade 3

	Cognitive Level 3 min/%	Cognitive Level 4 min/%	Cognitive Level 5,6 min/%
Engagement			
Engaged Time	104/87	103/90	110/92
Off-task Time	16/13	11/10	10/8
Types of Engagement ¹			
Content	100/98	94/99	95/95
Directions	2/2	1/1	5/5
Grouping			
Individual	0/0	0/0	5/4
Small Group	60/48	58/48	58/46
Large Group	66/52	63/52	63/50
Interactions			
Target Speaking	9/7	9/7	11/9
Target Listening	15/12	16/13	9/7
None	102/81	95/79	106/84
Interaction Other Party			
Teacher	20/83	22/85	13/72
Pupil	1/4	4/15	5/28
Other Adult	3/13	0/0	0/0

¹Many of the minutes observed in subcategories fail to sum to the total time because of other codes which were infrequently used or data were missing or coding errors.

The pictures of class 1 and class 3 show high engagement on content with virtually no differences between students. Class 2, on the other hand, exhibits much lower engagement with more time on directions for all students. Only pupil/pupil interactions vary by cognitive level (31% to 46%), but the difference is not significant ($\chi^2 = 1.63$, $p < .05$).

Overall, these data suggest that differences in grouping of students are due to grade. Grade 1 and Grade 2 children are working in small groups and individually for part of mathematics instruction while large groups and no individual work are common in Grade 3. Differences in engaged time are due to individual teachers. Only pupil/pupil interactions are plausible due to cognitive level of the children, with higher levels more likely to interact, but this occurs infrequently and only where such interactions are allowed.

Teacher Behaviors

The data for number of minutes and percent of time teacher actions were coded are first presented as they related to target children of different cognitive levels. Then, the teacher behaviors are tabulated by grade, by class in Grade 3, and by cognitive level within class for Grade 3 in which there was more than one class.

Cognitive level. The number of minutes and percent of time coded to six teacher behavior categories are presented in Table 11. Overall, three differences are striking across cognitive levels. First, the percent of time speaking to individual children decreases from 67% to 53% ($\chi^2 = 12.95$, $p < .01$). Second the time spent speaking about directions decreases (39% to 27%, $\chi^2 = 9.77$, $p < .01$). And in the same vein, the

Table 11
Observed Minutes and Percent of Time of
Teacher Behaviors by Cognitive Level of Children

	Cognitive Level 1 min/%	Cognitive Level 2 min/%	Cognitive Level 3 min/%	Cognitive Level 4 min/%	Cognitive Level 5,6 min/%
Interaction					
Listening	127/19	231/16	139/13	50/10	62/14
Speaking	394/60	837/58	722/66	310/60	292/64
None	141/21	380/26	235/21	154/30	97/21
Speaking/Large Group ¹	83/21	190/23	189/26	90/23	81/28
Speaking/Small Group	47/12	116/14	100/14	56/18	55/19
Speaking/Individual	264/67	529/63	433/60	184/59	156/53
Speaking/Content	233/59	479/57	475/66	204/66	203/69
Speaking/Directions	155/39	327/39	228/31	81/26	80/27
Low Level Questions	84/13	178/12	196/18	82/16	90/20
Direction Related Questions	12/2	78/5	68/6	51/10	52/11
No Feedback	592/83	1334/92	1018/93	481/93	427/94
Feedback/Individual	60/91	98/93	70/95	27/87	22/88
Low Information Feedback	69/99	114/100	75/94	31/91	24/92
High Information Feedback	1/1	0/0	5/6	3/9	2/8
Explaining Content	72/11	166/11	182/17	75/15	75/17
Explaining Directions	143/22	254/18	164/15	38/7	29/6

¹Many of the minutes observed in subcategories fail to sum to the total time because of other codes which were infrequently used or data were missing or coding errors.

percentage of time explaining directions decreases from 22% to 6% ($\chi^2 = 42.09$, $p < .01$).

Grade. The data on teacher behaviors by grade are presented in Table 12. The decreasing percent of time spent on directions found in the previous section appears to be a function of grade rather than cognitive level. The percentage of time teachers speak about directions decreases from 42% to 28% from Grade 1 to Grade 3 ($\chi^2 = 10.90$, $p < .01$).

Class in Grade 3. The differences of speaking on content for grade however appear to be teacher or class specific (see Table 13). The differences between the first-grade teacher (see Table 12) and two of the third-grade teachers on content remain significant. For example, in Grade 1, 57% of the time speaking is on content while for class 1 in Grade 3, 82% is on content ($\chi^2 = 60.7$, $p < .01$). But for class 2, Grade 3, again 57% is on content. However, the percentage of time teachers explain directions appears to be a grade effect since all three Grade 3 teachers spend less time (6%, 11%, and 3%) than either the Grade 1 or Grade 2 teachers (21% and 20%) (see Table 12).

Cognitive level within class. The data on teacher behaviors related to children of differing cognitive levels are presented for each class in Tables 14 to 18. For three of the classes (Grade 1, Grade 2, and class 2, Grade 3), there are no striking differences in terms of time spent for children of different cognitive levels. In class 1, Grade 3 (Table 16), the time spent speaking on content increased from 78% to 85% across levels but was found not to be significant ($\chi^2 = 248$, $p < .05$). In class 2, Grade 3 (Table 18), the time spent by the teacher speaking on content decreased significantly across levels from 82% to 66% ($\chi^2 = 7.50$, $p < .01$).

Table 12
Observed Minutes and Percent of Time of
Teacher Behaviors by Grade

	Grade 1 min/%	Grade 2 min/%	Grade 3 min/%
Interaction			
Listening	187/17	206/18	216/11
Speaking	640/58	677/59	1238/64
None	276/25	254/22	485/25
Speaking/Large Group ¹	91/14	209/31	313/25
Speaking/Small Group	82/13	65/10	227/18
Speaking/Individual	467/73	402/59	697/56
Speaking/Content	367/57	404/60	823/66
Speaking/Directions	268/42	256/38	347/28
Low Level Questions	135/12	157/14	338/17
Direction Related Questions	33/3	29/3	199/10
No Feedback	1006/91	1035/91	1819/94
Feedback/Individual	79/90	89/94	109/92
Low Information Feedback	97/100	101/98	115/93
High Information Feedback	0/0	2/2	9/7
Explaining Content	130/12	117/10	323/17
Explaining Directions	235/21	228/20	165/9

¹ Many of the minutes observed in subcategories fail to sum to the total time because of other codes which were infrequently used or data were missing or coding errors.

Table 13
Observed Minutes and Percent of Time
of Teacher Behaviors by Class, Grade 3

	Class 1 min/%	Class 2 min/%	Class 3 min/%
Interaction			
Listening	55/12	129/12	32/8
Speaking	290/63	681/62	267/71
None	116/25	294/27	75/20
Speaking/Large Group ¹	128/44	134/20	51/19
Speaking/Small Group	41/14	107/16	79/29
Speaking/Individual	121/42	439/64	137/51
Speaking/Content	239/82	391/57	193/71
Speaking/Directions	45/15	240/35	62/23
Low Level Questions	94/20	172/16	72/19
Direction Related Questions	22/5	125/11	52/14
No Feedback	434/94	1025/93	360/95
Feedback/Individual	24/92	71/93	14/88
Low Information Feedback	23/82	77/99	15/83
High Information Feedback	5/18	1/1	3/17
Explaining Content	96/21	139/13	88/23
Explaining Directions	26/6	126/11	13/3

¹ Many of the minutes observed in subcategories fail to sum to the total time because of other codes which were infrequently used or data were missing or coding errors.

Table 14
Observed Minutes and Percent of Time of
Teacher Behaviors by Cognitive Level Within Grade 1

	Cognitive Level 1 min/%	Cognitive Level 2 min/%	Cognitive Level 3 min/%
Interaction			
Listening	81/19	81/18	27/12
Speaking	253/58	254/56	135/62
None	100/23	121/27	55/25
Speaking/Large Group ¹	39/15	37/15	15/11
Speaking/Small Group	32/13	31/12	19/14
Speaking/Individual	182/72	186/73	101/75
Speaking/Content	151/60	143/56	75/56
Speaking/Directions	99/39	109/43	60/44
Low Level Questions	54/12	50/11	33/15
Direction Related Questions	10/2	16/4	7/3
No Feedback	384/88	419/92	207/95
Feedback/Individual	42/89	29/88	8/100
Low Information Feedback	50/100	37/100	10/100
High Information Feedback	0/0	0/0	0/0
Explaining Content	48/11	53/12	29/13
Explaining Directions	89/21	93/20	53/25

¹ Many of the minutes observed in subcategories fail to sum to the total time because of other codes which were infrequently used or data were missing or coding errors.

Table 15
Observed Minutes and Percent of Time of
Teacher Behaviors by Cognitive Level Within Grade 2

	Cognitive Level 1 min/%	Cognitive Level 2 min/%	Cognitive Level 3 min/%
Interaction			
Listening	44/20	106/18	54/16
Speaking	139/62	331/57	205/62
None	41/18	143/25	70/21
Speaking/Large Group ¹	44/32	102/31	63/31
Speaking/Small Group	15/11	35/11	15/7
Speaking/Individual	80/58	193/58	127/62
Speaking/Content	80/58	194/59	128/62
Speaking/Directions	56/40	125/38	75/36
Low Level Questions	28/13	76/13	51/15
Direction Related Questions	2/1	15/3	12/4
No Feedback	204/91	530/91	297/90
Feedback/Individual	18/95	44/98	27/87
Low Information Feedback	19/95	50/100	32/97
High Information Feedback	1/5	0/0	1/3
Explaining Content	24/11	52/9	41/12
Explaining Directions	54/24	111/19	63/19

¹Many of the minutes observed in subcategories fail to sum to the total time because of other codes which were infrequently used or data were missing or coding errors.

Table 16
Observed Minutes and Percent of Time of Teacher Behaviors
by Cognitive Level Within Class 1, Grade 3

	Cognitive Level 3 min/%	Cognitive Level 4 min/%	Cognitive Level 5,6 min/%
Interaction			
Listening	13/8	12/10	30/16
Speaking	110/71	62/53	118/62
None	30/19	43/37	43/23
Speaking/Large Group ¹	53/48	22/35	53/45
Speaking/Small Group	14/13	11/18	16/14
Speaking/Individual	53/39	29/47	49/41
Speaking/Content	87/78	52/84	100/85
Speaking/Directions	23/21	7/11	15/13
Low Level Questions	31/20	20/17	43/23
Direction Related Questions	10/6	4/3	8/4
No Feedback	143/93	112/96	179/94
Feedback/Individual	10/100	4/80	10/91
Low Information Feedback	8/73	3/60	12/100
High Information Feedback	3/27	2/40	0/0
Explaining Content	49/26	20/17	36/19
Explaining Directions	13/8	6/5	7/1

¹ Many of the minutes observed in subcategories fail to sum to the total time because of other codes which were infrequently used or data were missing or coding errors.

Table 17
Observed Minutes and Percent of Time of Teacher Behaviors
by Cognitive Level Within Class 2, Grade 3

	Cognitive Level 2 min/%	Cognitive Level 3 min/%	Cognitive Level 4 min/%	Cognitive Level 5,6 min/%
Interaction				
Listening	46/11	33/12	32/12	18/13
Speaking	254/61	178/65	158/58	91/67
None	116/28	61/22	82/30	27/20
Speaking/Large Group ¹	51/20	39/22	30/19	14/15
Speaking/Small Group	50/20	22/12	22/14	13/14
Speaking/Individual	152/60	117/66	106/67	64/70
Speaking/Content	144/57	107/60	93/59	47/52
Speaking/Directions	93/37	57/32	51/32	39/43
Low Level Questions	54/13	49/18	45/17	24/18
Direction Related Questions	47/11	29/11	27/10	22/16
No Feedback	389/94	251/93	248/91	129/95
Feedback/Individual	25/93	20/100	20/91	6/86
Low Information Feedback	27/100	19/95	24/100	7/100
High Information Feedback	0/0	1/5	0/0	0/0
Explaining Content	61/15	38/14	25/9	15/11
Explaining Directions	50/12	31/11	27/10	18/13

¹ Many of the minutes observed in subcategories fail to sum to the total time because of other codes which were infrequently used or data were missing or coding errors.

Table 18
Observed Minutes and Percent of Time of Teacher Behaviors
by Cognitive Level Within Class 3, Grade 3

	Cognitive Level 3 min/%	Cognitive Level 4 min/%	Cognitive Level 5,6 min/%
Interaction			
Listening	12/10	6/5	14/11
Speaking	94/75	90/71	83/66
None	19/15	29/23	27/21
Speaking/Large Group ¹	19/20	18/20	14/16
Speaking/Small Group	30/32	23/25	26/31
Speaking/Individual	45/47	49/54	43/51
Speaking/Content	78/82	59/65	56/66
Speaking/Directions	13/14	23/25	26/31
Low Level Questions	32/25	17/13	23/18
Direction Related Questions	10/8	20/16	22/17
No Feedback	120/95	121/96	119/86
Feedback/Individual	5/100	3/75	6/4
Low Information Feedback	5/100	4/80	5/4
High Information Feedback	0/0	1/20	2/1
Explaining Content	34/27	30/24	24/19
Explaining Directions	4/3	5/4	4/3

¹ Many of the minutes observed in subcategories fail to sum to the total time because of other codes which were infrequently used or data were missing or coding errors.

In summary, while teacher behaviors vary considerably across teachers, differences are more due to grade, or individual teaching style, or grouping patterns within classes than they are to differential treatment of students with different levels of cognitive capacity.

Teacher Behavior/Pupil Engagement Interactions

Teacher actions coded while children were engaged are reported in this section in number of minutes and percentage of time. As with the previous sections, the data were first aggregated for children of differing cognitive levels, then grade, class within Grade 3, and finally cognitive level within class.

Cognitive level. The overall data on time pupils of differing cognitive levels were engaged when teachers were doing different things is reported in Table 19. First, when teachers are speaking, children increase in engagement from 65% of the time at CL1 to 86% at CL5,6 ($\chi^2 = 36.47$, $p < .01$). Second, the overall pattern is similar regardless of to whom the teacher is speaking, and even when the teacher is not speaking (62% engagement to 89%, $\chi^2 = 37.99$, $p < .01$). Third, in the same manner, pupil engagement increases from 51% to 91% from CL1 to CL5,6 ($\chi^2 = 39.65$, $p < .01$) when there are no teacher interactions. Finally, the same pattern of increase in engagement is apparent when teachers question students or provide information.

Grade. The data on pupil engagement for various teacher actions by grade is presented in Table 20. The differences found in the previous section appear to be more a function of grade than of cognitive level. Overall engagement when teachers are speaking increases by grade from 59% in Grade 1 to 73% in Grade 3 ($\chi^2 = 69.10$, $p < .01$). Engagement when teachers are not

Table 19

Observed Minutes and Percent of Time of Interactions of
Teacher Behaviors and Pupil Engagement by Cognitive Level of Children

	Cognitive Level 1 min/%	Cognitive Level 2 min/%	Cognitive Level 3 min/%	Cognitive Level 4 min/%	Cognitive Level 5,6 min/%
Teacher Speaking/					
Pupil Engaged	254/65	518/66	509/73	216/76	241/86
Pupil Off-task	137/35	267/34	188/27	69/24	40/14
Pupil Engaged When Teacher Speaking to:					
Individual	174/67	306/61	289/69	128/73	123/79
Small Group	26/55	78/71	75/82	33/72	44/92
Large Group	54/65	133/77	145/78	55/87	74/95
Not Speaking	166/62	332/63	211/63	115/76	136/89
Pupil Engaged When Teacher:					
Listening	94/75	145/68	81/60	35/74	52/87
Pupil Engaged When:					
No Interactions	72/51	188/60	130/66	79/76	82/91
Pupil Engaged When Teacher Asks:					
Low Level Questions	51/62	114/68	141/75	60/77	80/92
High Level Questions	7/88	15/75	17/85	15/100	15/94
Questions About Directions	8/67	41/59	46/70	34/68	39/78
Pupil Engaged When Teacher Provides:					
Low Information Feedback	43/62	68/62	50/70	20/71	20/83
Positive Feedback	32/65	46/66	37/77	10/83	15/83
Information About Content	53/74	106/68	147/82	57/83	64/90
Explains Directions	87/61	159/67	101/63	25/69	22/79

Table 20

Observed Minutes and Percent of Time of Interactions of
Teacher Behaviors and Pupil Engagement by Grade

	Grade 1 min/%	Grade 2 min/%	Grade 3 min/%
Teacher Speaking/			
Pupil Engaged	356/59	463/70	919/78
Pupil Off-task	245/41	197/30	259/22
Pupil Engaged When Teacher Speaking to:			
Individual	253/57	265/68	502/74
Small Group	51/67	45/69	160/80
Large Group	52/63	153/75	256/86
Not Speaking	203/50	308/72	449/76
Pupil Engaged When Teacher:			
Listening	104/61	151/76	152/72
Pupil Engaged When:			
No Interactions	99/42	157/69	295/78
Pupil Engaged When Teacher Asks:			
Low Level Questions	75/60	108/71	263/81
High Level Questions	8/67	19/83	42/95
Questions About Directions	15/52	20/69	133/70
Pupil Engaged When Teacher Provides:			
Low Information Feedback	44/48	67/68	90/80
Positive Feedback	32/54	56/72	52/87
Information About Content	83/68	89/77	255/82
Explains Directions	131/58	149/67	114/72

speaking increases from 50% to 76% ($\chi^2 = 71.70$, $p < .01$). Similarly, pupil engagement when there are no interactions increases from 42% to 78% ($\chi^2 = 82.32$, $p < .01$), as do all engagement rates related to teacher questioning and providing information.

Class within Grade 3. Again for third grade, these data have been further subdivided for each class. The information on pupil engagement when teachers did certain actions is presented for these classes in Table 21. As would be expected from previous analyses, class 2 in Grade 3 is different from classes 1 and 3 in Grade 3. Engagement rates in class 2 are lower in all categories than the other two classes. In fact, the grade level effect noted previously may be partially an individual teacher effect.

Cognitive level within class. The engagement data for children of differing cognitive levels within each class are presented in Tables 22 to 26. Although there is some variation in engagement in each class for children of differing cognitive levels, no discernible pattern of differences in any class is apparent.

In summary, the data relating pupil engagement to type of teacher behavior suggest that differences are due to grade level and teacher style and not to differences in cognitive capacity among the students within each class.

Conclusions

The question raised at the beginning of this paper now can be answered. Do children who differ in cognitive capacity receive different instruction? For students in the five classes observed in this study, definitely not.

Table 21

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Observed Minutes and Percent of Time of Interactions of
Teacher Behaviors and Pupil Engagement by Class Within Grade 3

	Class 1 min/%	Class 2 min/%	Class 3 min/%
Teacher Speaking/			
Pupil Engaged	263/99	437/66	219/88
Pupil Off-task	2/1	226/34	31/12
Pupil Engaged When Teacher Speaking to:			
Individual	109/99	275/63	118/87
Small Group	31/100	69/59	60/90
Large Group	123/99	92/74	41/85
Not Speaking	138/96	213/62	98/94
Pupil Engaged When Teacher:			
Listening	51/98	73/57	28/90
Pupil Engaged When:			
No Interactions	88/95	141/65	66/96
Pupil Engaged When Teacher Asks:			
Low Level Questions	86/99	116/76	61/92
High Level	23/100	1/100	18/90
Questions About Directions	21/100	70/60	42/82
Pupil Engaged When Teacher Provides:			
Low Information Feedback	22/100	56/73	12/92
Positive Feedback	20/100	23/82	9/75
Information About Content	86/100	95/69	74/86
Explains Directions	24/96	80/66	10/91

Table 22

Observed Minutes and Percent of Time of Interactions of
Teacher Behaviors and Pupil Engagement by Cognitive Level Within Grade 1

	Cognitive Level 1 min/%	Cognitive Level 2 min/%	Cognitive Level 3 min/%
Teacher Speaking/			
Pupil Engaged	156/62	118/55	82/61
Pupil Off-task	97/38	96/45	53/39
Pupil Engaged When Teacher Speaking to:			
Individual	113/62	82/51	58/58
Small Group	20/63	15/60	16/84
Large Group	23/59	21/72	8/53
Not Speaking	104/57	71/46	28/40
Pupil Engaged When Teacher:			
Listening	58/72	38/58	8/32
Pupil Engaged When:			
No Interactions	46/46	33/36	20/44
Pupil Engaged When Teacher Asks:			
Low Level Questions	34/63	22/58	19/58
High Level Questions	2/100	3/50	3/75
Questions About Directions	7/70	5/42	3/43
Pupil Engaged When Teacher Provides:			
Low Information Feedback	30/60	10/30	4/44
Positive Feedback	20/65	9/45	3/38
Information About Content	33/69	28/62	22/76
Explains Directions	49/55	50/61	32/60

Table 23

Observed Minutes and Percent of Time of Interactions of
Teacher Behaviors and Pupil Engagement by Cognitive Level Within Grade 2

	Cognitive Level 1 min/%	Cognitive Level 2 min/%	Cognitive Level 3 min/%
Teacher Speaking/ Pupil Engaged	98/71	228/70	137/70
Pupil Off-task	40/29	98/30	59/30
Pupil Engaged When Teacher Speaking to:			
Individual	61/77	123/64	81/67
Small Group	6/40	27/77	12/80
Large Group	31/70	78/80	44/72
Not Speaking	62/73	171/74	75/67
Pupil Engaged When Teacher:			
Listening	36/82	79/76	36/71
Pupil Engaged When:			
No Interactions	26/63	92/72	39/65
Pupil Engaged When Teacher Asks:			
Low Level Questions	17/61	55/72	36/75
High Level Questions	5/83	12/86	2/67
Questions About Directions	1/50	9/60	10/83
Pupil Engaged When Teacher Provides:			
Low Information Feedback	13/68	36/72	18/62
Positive Feedback	12/67	28/72	16/76
Information About Content	20/83	36/71	33/80
Explains Directions	38/72	75/69	36/59

Table 24

Observed Minutes and Percent of Time of Interactions of Teacher
Behaviors and Pupil Engagement by Cognitive Level Within Class 1, Grade 3

	Cognitive Level 3 min/%	Cognitive Level 4 min/%	Cognitive Level 5,6 min/%
Teacher Speaking/			
Pupil Engaged	104/99	46/98	113/100
Pupil Off-task	1/1	1/2	0/0
Pupil Engaged When Teacher Speaking to:			
Individual	39/100	22/96	48/100
Small Group	13/100	6/100	12/100
Large Group	52/98	18/100	53/100
Not Speaking	39/95	34/94	65/97
Pupil Engaged When Teacher:			
Listening	13/93	9/100	19/100
Pupil Engaged When:			
No Interactions	27/96	25/93	36/95
Pupil Engaged When Teacher Asks:			
Low Level Questions	29/100	15/94	42/100
High Level Questions	6/100	7/100	10/100
Questions About Directions	9/100	4/100	8/100
Pupil Engaged When Teacher Provides:			
Low Information Feedback	8/100	2/100	12/100
Positive Feedback	9/100	2/100	9/100
Information About Content	38/100	15/100	33/100
Explains Directions	12/92	5/100	7/100

Table 25

Observed Minutes and Percent of Time of Interactions of Teacher
Behaviors and Pupil Engagement by Cognitive Level Within Class 2, Grade 3

	Cognitive Level 2 min/%	Cognitive Level 3 min/%	Cognitive Level 4 min/%	Cognitive Level 5,6 min/%
Teacher Speaking/				
Pupil Engaged	172/70	111/64	95/62	59/66
Pupil Off-task	73/30	63/36	59/38	31/34
Pupil Engaged When Teacher Speaking to:				
Individual	101/68	72/62	63/59	39/61
Small Group	36/72	13/65	10/50	10/77
Large Group	34/76	26/68	22/79	10/77
Not Speaking	90/65	40/51	53/62	30/70
Pupil Engaged When Teacher:				
Listening	28/62	14/42	20/63	11/61
Pupil Engaged When:				
No Interactions	63/67	26/58	33/61	19/76
Pupil Engaged When Teacher Asks:				
Low Level Questions	37/69	32/65	28/62	19/79
High Level Questions	0/0	0/0	1/100	0/0
Questions About Directions	27/64	16/57	14/54	13/62
Pupil Engaged When Teacher Provides:				
Low Information Feedback	22/81	14/74	17/71	3/43
Positive Feedback	9/82	7/88	7/100	0/0
Information About Content	42/70	26/68	17/68	10/67
Explains Directions	34/72	18/60	16/59	12/67

Table 26

Observed Minutes and Percent of Time of Interactions of Teacher
Behaviors and Pupil Engagement by Cognitive Level Within Class 3, Grade 3

	Cognitive Level 3 min/%	Cognitive Level 4 min/%	Cognitive Level 5,6 min/%
Teacher Speaking/			
Pupil Engaged	75/85	75/89	69/88
Pupil Off-task	13/15	9/11	9/12
Pupil Engaged When Teacher Speaking to:			
Individual	39/87	43/91	36/84
Small Group	21/88	17/85	22/96
Large Group	15/79	15/88	11/92
Not Speaking	29/91	28/93	41/98
Pupil Engaged When Teacher:			
Listening	10/83	6/100	12/92
Pupil Engaged When:			
No Interactions	18/95	21/91	27/100
Pupil Engaged When Teacher Asks:			
Low Level Questions	25/89	17/100	19/90
High Level Questions	6/86	7/100	5/83
Questions About Directions	8/80	16/80	18/86
Pupil Engaged When Teacher Provides:			
Low Information Feedback	6/100	1/50	5/100
Positive Feedback	2/100	1/33	6/86
Information About Content	28/82	25/86	21/91
Explains Directions	3/75	4/100	3/100

However, there is considerable variation in instruction both due to grade level and teaching style. The differences from Grades 1 and 2 to Grade 3 reflect a shift in emphasis and organization of activities that to a considerable extent may be due to change in school. Sandy Bay Infant School (Grades 1 and 2) is an open, activity oriented, individualized school. Waimea Heights on the other hand is a "primary" school where instruction is more formal and direct.

Classes 1 and 3 in Grade 3 clearly reflect good teaching following the direct instruction approach. Children are on task in large or small groups. Class 2 on the other hand, while following the same organizational features, is not very successful.

Thus, while instruction varies considerably, the variation is due to student grade level, school organization, and individual teaching style, rather than to differences in student cognitive level.

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